METHOD OF ISOLATING DATA IN A POWER LINE COMMUNICATIONS NETWORK

CROSS REFERENCE TO RELATED APPLICATIONS

1. This application claims priority under 35 U.S.C. § 119(e) from provisional application no. 60/177,237, filed January 20, 2000. The 60/177,237 provisional application is incorporated by reference herein, in its entirety, for all purposes.

INTRODUCTION

2. The present invention relates generally to the field of electrical communications via power lines. More particularly, the present invention relates to isolating data in a power line communications system.

BACKGROUND OF THE INVENTION

3. A typical electric distribution configuration has a transformer which steps medium voltage down to a few hundred volts AC (typically between 100 and 240 VAC). The Low Voltage (LV) is fed to several homes.

4. Referring to **Fig. 1**, the typical electric power distribution architecture is illustrated. No filter or other barrier is employed to isolate data from one residence to the next. Using this architecture for a power line communications system, typically a power line signal containing the data will be fed at the transformer. There are four potential problems with this topology for communications.

5. First, the bandwidth is shared between plural subscribers. Second, noise from another subscriber using a different type of power line communication system or noise from another subscriber's appliances may cause interference. Third, subscribers using the

same system can interact with each other. Fourth, since one subscriber receives the other subscriber's data, there is a lack of security.

6. Thus, what is needed is a way of isolating data from subscriber to subscriber to alleviate the problems discussed above.

SUMMARY OF THE INVENTION

7. It is an object of the present invention to enable isolation of data from subscriber to subscriber.

8. It is another object of the present invention to enable isolation of data from a subscriber to the distribution transformer.

9. Isolation structures to realize these objects are implemented in a centralized way at the distribution transformer, or alternatively, in a distributed way at each subscriber's premises. These implementations are made using low pass filters (which pass the power but block the data) and power line communications routers or power line communications repeaters.

BRIEF DESCRIPTION OF THE DRAWING

10. Additional objects and advantages of the present invention will be apparent in the following detailed description read in conjunction with the accompanying drawing figures.

11. **Fig. 1** illustrates a conceptual view of a typical electric distribution topology.

12. **Fig. 2** illustrates a block diagram view of centralized data isolation.

13. **Fig. 3** illustrates a block diagram view of an embodiment of the present invention having isolation before the power meter.

14. **Fig. 4** illustrates a block diagram view of an embodiment of the present invention having isolation after the power meter.

15. **Fig. 5** illustrates a block diagram view of an embodiment of the present invention having isolation bridging the power meter.

16. **Fig. 6** illustrates a block diagram view of an embodiment of the present invention having a LAN only topology with a filter before the meter.

17. **Fig. 7** illustrates a block diagram view of an embodiment of the present invention having a LAN only topology with a filter after the meter

DETAILED DESCRIPTION OF THE INVENTION

18. According to alternate embodiments, data isolation is accomplished in a centralized manner, in a distributed manner (i.e., at the subscriber), or in a hybrid manner that is a combination of centralized and distributed.

19. According to one aspect of the invention, a system provides for network communications isolation in a branch line connecting a subscriber device at a subscriber premises to a network. The system includes an electric power distribution transformer, a branch line (connected between the transformer and the subscriber's premises), a low pass filter, and a power line communications router. The low pass filter connected in the branch line at a location adjacent the transformer. The power line communications router is connected to the network and coupled to the branch line at a location adjacent the filter, on the subscriber side of the filter. When the subscriber device is coupled to the branch line, the subscriber device is coupled to the network and is isolated from the transformer by the filter.

20. According to another aspect of the invention a network coupler. The network coupler provides network communications isolation in a branch line connected to a subscriber premises through an electric power meter. The network coupler includes a low pass filter and a power line communications repeater. The low pass filter is coupled to the branch line adjacent to the power meter. The power line communications repeater is connected to the branch line across the low pass filter.

21. On the one hand, the power line communications repeater is connected across both the low pass filter and the power meter. In the alternative, the power line communications repeater is connected across only the low pass filter. The low pass filter is disposed either on the subscriber side of the power meter, or on the transformer side of the power meter.

22. According to yet another aspect of the present invention, a network isolator provides network communications isolation in a branch line connected to a subscriber premises through an electric power meter. The isolation is provided between a network located at the subscriber premises a transformer connected to the branch line. The network isolator includes a low pass filter. The low pass filter is coupled to the branch line adjacent to the power meter. The low pass filter is disposed either on the subscriber side of the power meter, or on the transformer side of the power meter.

23. Referring to **Fig. 2**, a centralized power line communications (PLC) router **210** is illustrated. The centralized PLC router **210** is connected separately to each branch line, which in turn connects to the subscriber. A filter **220** passes the high power electricity (100 VAC to 240 VAC) but blocks the power line communications signal. This filter **220** is implemented using electronic components such as inductors, capacitors and resistors.

This method requires splicing the electric power line and inserting the filter **210** in series with the line **230**.

24. A less expensive way of implementing this filter, which does not require cutting the power line, uses a ferrite toroid as a common-mode choke. This is done by simply feeding an electric power line through a toroid, thus allowing the electric power (50-60Hz) to pass yet blocking the higher frequency signals that contain the power line communications data. In most situations the toroid method is preferred.

25. In conjunction with the centralized method, or as an alternative, data is isolated using a distributed approach. In this approach a filter (such as described above) is placed at the subscriber's location. A power line data repeater, which regenerates the data, is connected in parallel with the filtering device. This topology addresses the noise, interference and security issues. However, the bandwidth is shared between each subscriber connected to the transformer.

26. Referring to **Fig. 3** a block diagram view of an embodiment of the present invention having isolation before the power meter **300** is illustrated. This is an implementation according to a distributed topology. A PLC repeater **310** and a filter **320** are connected in parallel with one another and in series with the power meter **300**. The power meter **300** is disposed between the subscriber's house **340** and the PLC repeater **310**.

27. Referring to **Fig. 4** a block diagram view of an embodiment of the present invention having isolation after the power meter **400** is illustrated. This is another implementation according to a distributed topology. A PLC repeater **410** and a filter **420** are connected in parallel with one another and in series with the power meter **400**. The

PLC repeater **410** is disposed between the subscriber's house **440** and the power meter **400**.

28. Functionally, the differences between the distributed topology implementations illustrated in **Figs. 3 & 4** are insubstantial. However, depending on the deployment one may be easier to implement than the other.

29. Referring to **Fig. 5**, a block diagram view of an embodiment of the present invention having isolation bridging the power meter is illustrated. A filter **520** is connected in series with the power meter **500**, and that series combination is connected in parallel with a PLC repeater **510**.

30. Although the distributed topology of this embodiment is potentially difficult to deploy, it has certain performance advantages. Performance according to this embodiment is superior since the electric meter **500** presents some attenuation of the power line communication signals. Thus, in this topology the PLC repeater **510** repeats signals across the filter **520** and electric meter **500**. This achieves a better signal-to-noise ratio by avoiding the attenuation that would otherwise be introduced by the electric meter **500**.

31. Referring to **Figs. 6 & 7**, a filtering device is placed on the power line adjacent the subscriber's premises. This is useful in cases where an internal Local Area Network (LAN) exists within the premises and access to a Wide Area Network (WAN) in not required. This provides security for the LAN as well as reduces interference from the outside. It also isolates the LAN from the WAN in case a WAN is deployed. According to the embodiment illustrated in **Fig. 6**, the filter **610** and the electric meter **620** are connected in a serial with one another, with the filter **610** before the electric meter **620**. Alternatively, **Fig. 7** illustrates the filter **710** and the electric meter **720** as being connected

in a serial with one another, with the filter **710** placed after the electric meter **720**. The arrangement according to both of these illustrated topologies functionally perform the same. However, depending on the deployment one may be easier to implement than the other.

32. The present invention has been described in terms of preferred embodiments, however, it will be appreciated that various modifications and improvements may be made to the described embodiments without departing from the scope of the invention.